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MODEL: 309A & 319

REPORT NO. 3

APPLICATION OF CIRCULATION CONTROL TO
AN AIRPLANE OF MILITARY LIAISON TYPE

NONR CONTRACTS 234(00) AND 856(00)

Cessna Aircraft Company
Wichita, Kansas

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Cessna
Aircraft Company
Wichita, Kansas

PERIODIC PROGRESS REPORT

MODEL 309A & 319: REPORT NO. 3

APPLICATION OF CIRCULATION CONTROL TO
AN AIRPLANE OF MILITARY LIAISON TYPE.

NONR CONTRACTS 234(00) AND 856(00)

REPORT DATE: 7 November 1952

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CESSNA AIRCRAFT CO.

WICHITA, KANSAS

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MODEL 309A & 319

FORM 494

NONR CONTRACTS 234(00) and 856(00)

APPLICATION OF CIRCULATION CONTROL TO AN AIRPLANE OF MILITARY LIAISON TYPE

This report covers the period from 5 September 1952 to 1 November 1952.

CESSNA MODEL 309 - CONTRACT NO. 234(00)

Analysis

Comparative study to evaluate efficiency of the pumping system installed on Cessna Model 309A was initiated and conducted in three phases:

1. Tests of the mock-up (presented in University of Wichita Report No. 071).
2. Tests of the system on the ground.
3. Flight tests of system performance.

Phase two has been completed, and results show the BLC system requires 21.7 shaft horsepower to deliver a total flow quantity of 102 ft³/sec. These values were determined by total and dynamic pressure surveys in conjunction with measured electrical current and voltages, and with known generator efficiency. Measurements were made with engine operating at 1500 rpm, the flap deflected full down (45°), and with the aileron neutral and fully dropped (30° down). Aileron position had an insignificant effect on power and quantity flow.

An overall efficiency of 20.5 percent including duct losses were determined from the product of individual component efficiencies. These were computed from horsepower input and output measured electrically, at the generator and the fan motors, and in the following manner for the duct:

Duct input = $P \times Q/550$ where P is the pressure rise across the fans and Q is the flow quantity.

Duct output = $Q \times q_d/550$ where q_d is average dynamic pressure in the blowing slot.

The individual component efficiencies are shown in Figure 1.

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Figure 2 illustrates how the engine shaft horsepower required by the BLC system is divided among each component. The greatest power losses are electrical and occur in the generator and fan motors; however, the efficiencies of generator, motor fan combination, and ducting are approximately the same. This indicates that an equal improvement in efficiency for any of the three components would result in the same system improvement if other component efficiencies were constant. Actually, the motor fan units were operating very close to peak condition, and an improved duct efficiency would be accompanied by a slight decrease in motor-fan efficiency, but this overall effect would be quite small.

The range of duct losses measured during the ground test is illustrated by Figure 3. Friction effect and length of the forward ducts account for greater losses. The wide range of experimental values for similar ducts, but opposite wing panels, signifies the difficulty of accurately predicting losses in projected designs.

The analysis of results collected for phases 2 and 3 will be reported by Cessna Report 1309-7.

Design and Construction

Upon completion of the ground tests on the electric motor fan circulation control system in the 309A, the beginning of the flight tests were held up pending the delivery of the DR-2 Variation Camera.

Longitudinal static stability flight tests were made without this camera, since the required information could be obtained by use of a Gray Autograph. These tests were completed on 24 October 1952. The results of these and further flight tests will be covered by Cessna Report 1309-6.

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From the preceding flight tests it was determined that aileron and rudder trim tabs were required for dynamic stability and control flight tests. Engineering and design of the lateral trim system is completed, and the directional trim system will be completed by 7 November 1952.

An extensive investigation of the ground tests results indicated that a somewhat different method of instrumentation of the blowing slot was needed to determine the quantity flow through the wing. For this reason twenty-four pitot static heads were located at the exit to the blowing slot and connected to a multiple tube manometer in the fuselage. The airplane is now in the process of being flight tested to determine quantity flow.

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WICHITA, KANSAS

MODEL 309A & 319

FORM 404

CESSNA MODEL 319 - CONTRACT NO. 856(00)

Analysis

A preliminary study of systems for the pumping of air used by BLC on aircraft was partially completed and presented in Cessna Report No. 1309-5 under the title, "Investigation of Boundary Layer Pumping Systems" by R. K. Wattson, Jr.

Design and Construction

The 0.6 scale model of the 319 wing is nearing completion at Wichita University. The model is scheduled to be placed in the tunnel for the start of the tests on 1 December 1952.

Tests on the full scale vortex suction duct mock-up of the wing were completed at Wichita University. These tests were conducted to determine final duct diameter and configuration of this duct.

Design work on the Model 319 has been started. To date the following drawings have been started.

12319-6	Structure Assembly - Wing
12319-7	Cabin Modification
12319-8	Tail Wheel Installation
12319-9	Bulkhead Contour (Station 214.375)

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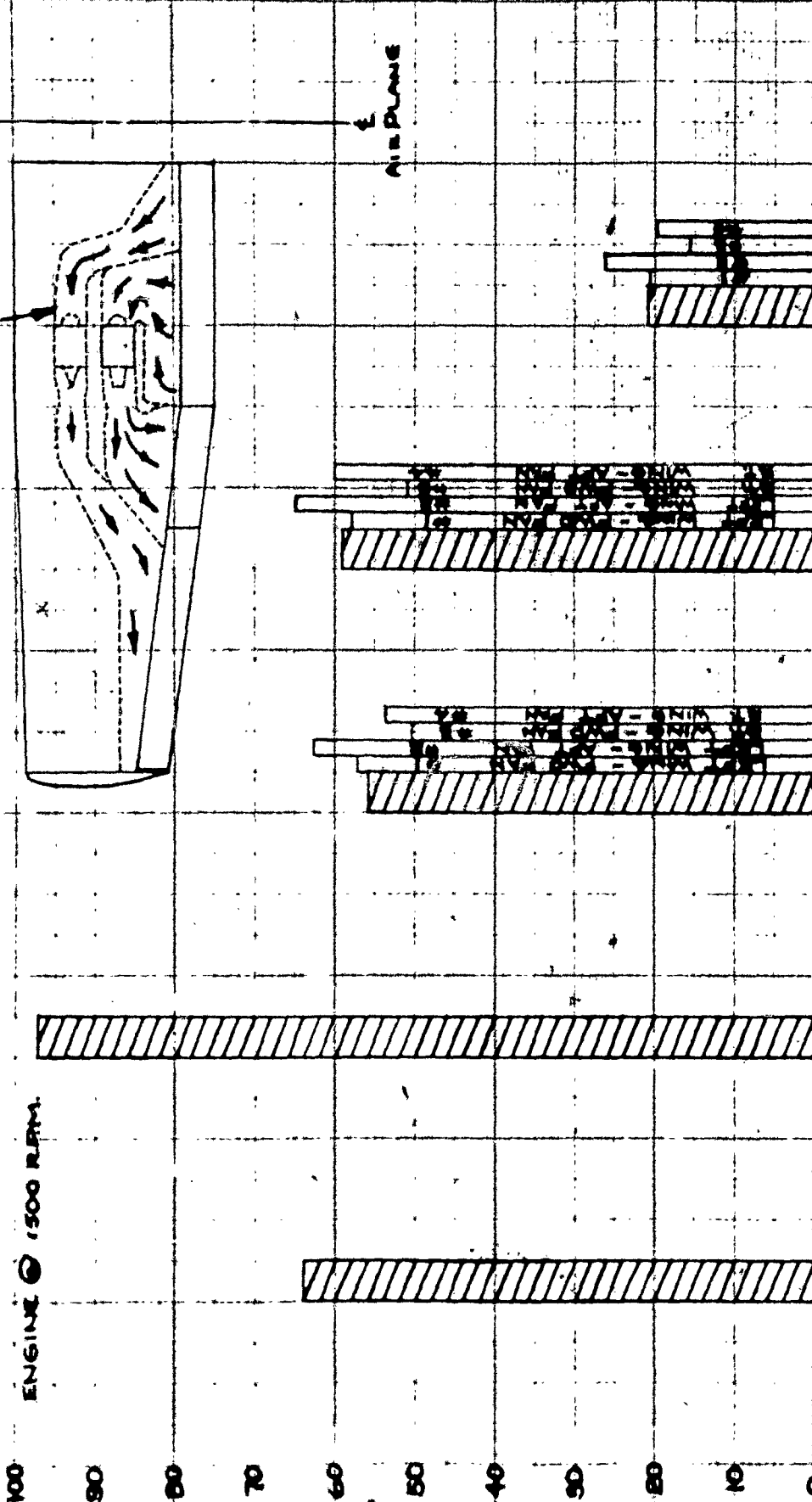
MODEL 309A
GROUND TESTS
BLC. SYSTEM EFFICIENCY

FLAPS FULL DOWN (45°)
AILERON NEUTRAL

ENGINE @ 1500 RPM

FWD DUCT

EFF %



AIR PLANE

SYSTEM TOTAL

DUCTING

MOTOR/FAN

POWER TRANSMISSION (ELECTRIC)

GENERATOR & DRIVE

FIG. NO. 1

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MODEL 809A
GROUND TEST
B.L.C. POWER REQD

FLAPS FULL DOWN (45°)
AILERONS NEUTRAL
ENGINE @ 1500 RPM

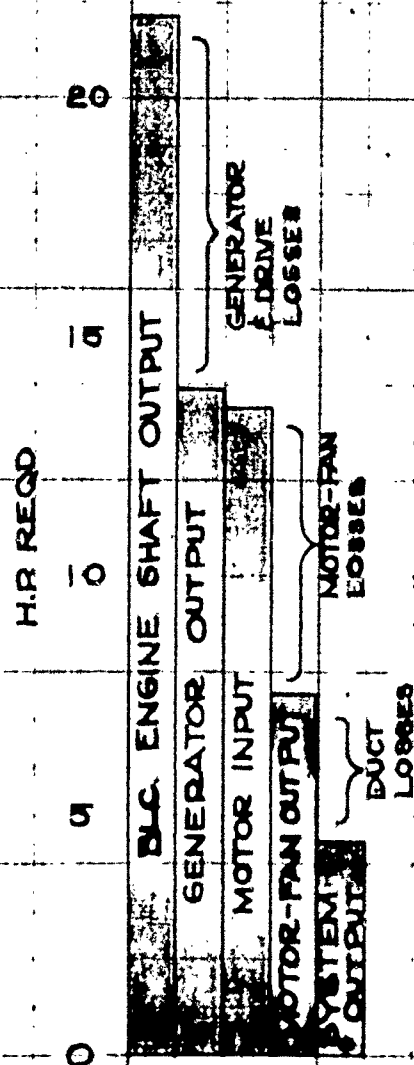


FIG. NO. 2

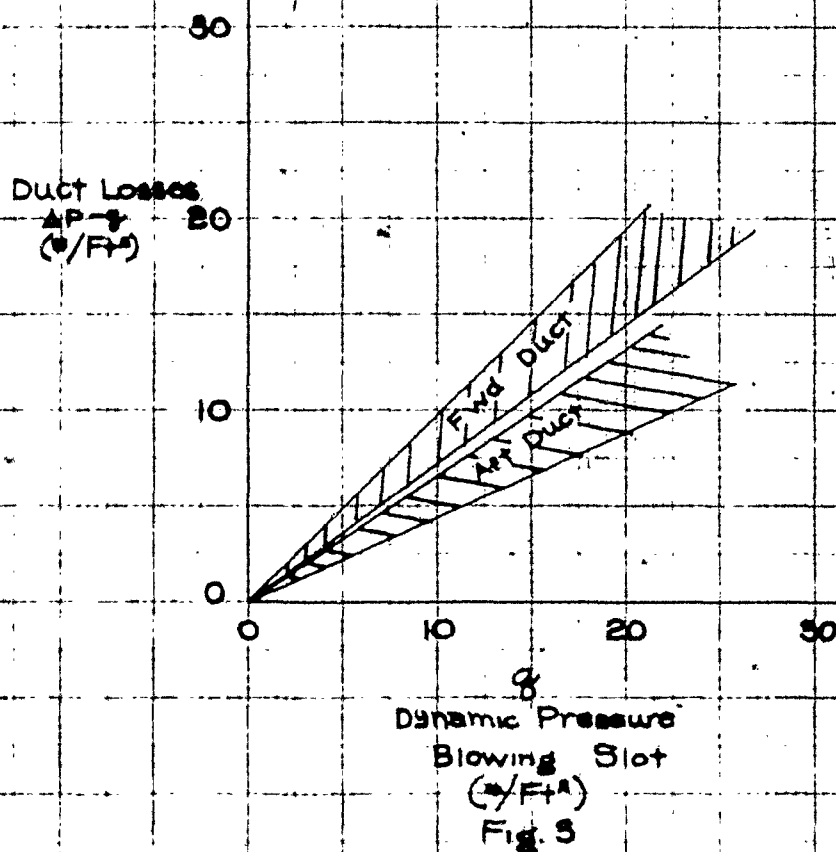
* POWER OUT PUT AT BLOWING SLOT
(DYNAMIC PRESSURE * FLOW QUANTITY/550)

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H.L. Myers

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Model 309A
Ground Test
Duct Losses
Flaps Full Down (45°)
Aileron Neutral
Engine @ 1500 R.P.M.



NOTE:

Losses Are Defined As The Difference Between Total Pressure Rise Across The Fan And The Dynamic Pressure In The Blowing Slot

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10-17-52

H.L. Tiller